

VITAL STATISTICS.

PART I.

ON THE COMPUTING A RATE OF MORTALITY AMONG PERSONS AFFECTED WITH VARIOUS DISEASES, AND ON A SET OF TABLES PREPARED BY THE AUTHOR.

IN the investigation of the law which governs the mortality among persons affected with diseases, it is necessary to take into consideration the peculiar circumstances of each disease, such as its various stages, the age, sex, profession or occupation of the person affected ; the influence of seasons, temperature, humidity, the prevailing winds, and other incidental conditions. We have thus presented to us a mass of materials which it would be impossible, with justice, to treat fully or even in any degree elaborately in the present limited space.

In this paper, therefore, it is only sought to give an outline of the method by which the data have been obtained, and of the processes to which they were submitted ; together with the considerations which induced their adoption.

At a subsequent period I purpose giving a general review of the whole question ; and of bringing under discussion each disease, with its facts, in a distinct and separate form.

That the mortality of particular diseases is governed by a law as unerring as that which is discovered in the general mass of lives is indisputable, although it has hitherto not been developed. And the immense advantage both scientifically and commercially that would result from the elucidation of such a law is also as indisputable. Hitherto the imperfection of our statistics has prevented any satisfactory deductions being made ; but the aggregation of the Medical Reports made to the Registrar-General, and other sources, afford a foundation for enquiry which must ultimately lead to the surest results.

On the commercial value of such a law we may be permitted to enlarge.

In all civilized countries, and especially in great cities, the constitution of every individual is in some degree operated upon by the artificial stimulants by which he is surrounded, and consequently every life is more or less diseased. Hitherto it has been deemed too delicate a calculation to estimate the individual chance of a life, and consequently in the rates calculated for general mortality a certain amount of disease is included. Now if it be possible to discover the law governing the mortality of diseased lives, the duration of the generally termed healthy lives can be more nicely calculated and the rate proportionally reduced.

The advantage of opening the means of Life Assurance to a large section of persons who have hitherto been debarred from it, can scarcely be overrated. In a moral as well as a commercial point of view, it will give to thousands comfort and support, and relieve the minds of those oppressed with disease in a manner that cannot be too highly appreciated.

Of its benefits to society there can be no dispute; but of the mode of obtaining the information necessary to secure a sufficient foundation for tables, there may be much difference of opinion. Under any circumstances it must require an enormous amount of labour, from the scattered and scanty nature of the materials; but as the science of statistics progresses, and governments and communities perceive how essential it is to social organization, more abundant and accessible data will be afforded.

It is reasonable to suppose that the progress in the estimation of human life in all its phases, will be as marked and as important as the advance in General Assurance has been from the period when one premium was taken for all ages and all conditions.

In the absence of this perfection of statistics we can only resort to the imperfect data opened by an industrious collection of scattered facts. Happily the general diffusion of scientific attainments affords some amount of data; and the liberality of a large and learned profession enables the enquirer to collect from medical men numerous facts. Hitherto this valuable source has only been used by private energy for particular and not public purposes. The laborious knowledge and scientific talent brought to bear upon one particular Life Office is a monument of the energy and genius of its founder and Actuary; but neither the data nor the results are the property of the public. The

subject may, therefore, be considered, as far as science is concerned, one yet to be explored and developed.

In making a first attempt in a region so rich in promise, but so little known, I have depended chiefly on three sources:—the voluminous records in the General Register Office; the Registers of Public and Private Institutions for Special Diseases; and the Returns of Medical Men. Other collateral sources, such as treatises on particular diseases; public enquiries, as in the case of epidemics; and of commissions on the effects on mortality caused by particular trades and professions, have also been referred to.

The advantage of computing into tables the chances of individual life affected with various maladies would be valuable not only to the public, but to the Medical Profession, and of course to Assurance Companies, who could then take every life presented to them, it being necessary only to fix the class to which each proposal would belong.

The Medical Profession will be benefitted by seeing the result of a large number of diseases tabulated according to age and other circumstances: and very important deductions may be made by physiological enquirers. The arrangement of so large a mass of medical facts cannot fail to suggest to active minds thoughts and perceptions of much value.

We cannot, indeed, cite a better authority, or quote a more apt illustration of the advantage of such labours, than is expressed in the following statement made by an able writer in the Journal of the Statistical Society.

“ There is no science in which statistical investigation is more necessary than in medicine; and there are few to which it has hitherto been less applied. The physician knows that certain medicines produce certain effects, that certain diseases usually last a certain time, and that some are more fatal than others; but he has never or rarely ascertained this by numerical computation; his knowledge is the result of an experience dependent upon memory alone, and liable to be influenced by partial or prejudiced views; and if he were to be asked what was the average duration of a disease, or in what proportion one disease was more fatal than another, he would be at a loss for an answer. On the Continent, the true value of statistical investigation, in ascertaining the results of diseases, has long been fully estimated; but in this country, the advantage of employing enumeration to obtain those results, and to investigate general facts, has only of late years come into importance.”

To those engaged in the Assurance of Lives the advantages resulting from such tables are too manifest to need much dissertation.

It will, above all things, introduce so nice a gradation of calculation that, as before observed, it will sift still finer the generally called healthy class, and give a firmer basis to each individual assurance by introducing a more scientific classification. It will greatly enlarge the sphere of Assurance business, and enable whole families to be assured who, having some hereditary taint, are precluded by the present method from assuring at all. In fact, it will create a great and beneficial revolution in the mode of assurance business, making it universal, and thus rendering what has hitherto been only partial and fragmentary, truly a Science.

We shall now proceed to give a rough outline of the manner in which the facts were collected, together with the formulæ made use of, in order to reduce the results to an intelligible, or rather applicable form.

In the first instance, the particulars of each case were carefully recorded under the following heads, viz:—place and date of death; sex; age coming under observation, or time when disease first appeared; age at death; profession or occupation; disease, or primary cause of death; duration till death; and the secondary or immediate cause of death.

The particulars of upwards of fifteen thousand cases have thus been collected.

The following are a few examples taken indiscriminately from the schedules.

Date of Death.	Sex.	Age coming under observation.	Age at Death.	Profession or Occupation.	Primary Cause of Death.	Duration till Death, in years.	Secondary Cause of Death.
15 October, 1846	F.	33	53	Wife of Cordwainer	Disease of Heart	20	Dropsy
22 Nov. "	F.	25	65		Imbecility	40	Exhaustion
21 June, 1847	F.	35	57	Wife of Porter	Umbilical Hernia	22	Operation
2 Dec. "	F.	29	49	Wife of Fruiterer	Asthma	20	Influenza
18 January, 1846	F.	42	49	Widow of Cabowner	Cancer	7	
8 June, "	F.	24	30	Wife of Upholsterer's Porter	Phthisis	6	

The diseases coming under observation in these facts, are as follows:—Disease of the Lungs, Asthma, Bronchitis, Chronic Catarrh, Emphysema, Pneumonia, Pleuritis, Disease of the Liver, Rheumatism, Gout, Rheumatic

Gout, Paralysis, Softening of the Brain, Disease of the Uterus, Ovarian Tumours and Ovarian Dropsy, Epilepsy, Tumours and External Abscesses, Scrofula, Phthisis, Disease of the Brain, Apoplexy, Disease of the Bladder, Disease of the Kidneys, Atrophy, Cancer, Insanity, Mania, Amentia, Dementia, Monomania, Melancholia, Idiocitas, Disease of the Stomach and Bowels, Enteritis, Gastritis, Peritonitis, Hernia, Disease of the Heart, and Angina Pectoris.

In the case of some diseases, such as Gout, Rheumatism, Hernia, and those of a lingering chronic nature, where the facts were not sufficiently numerous, special enquiry is being made through the medical profession, and schedules have been drawn up to suit the peculiar features of each class.

These facts were then separately abstracted under the heads of the different diseases, and for each variation of age, and a table for each disease with the following particulars was then constructed—

The 1st column represents the ages from 1 to 100 consecutively.

2nd.—The number entering at each age.

3rd.—The number remaining under observation from age preceding.

4th.—The total number under observation at each age.

5th.—The number dying, and

6th.—The mortality per cent. among those exposed to risk.

In order to correct any irregularities which might have occurred from the scantiness of the numbers, or other undue circumstances, another table was constructed from the one just described shewing the mortality per cent. for quinquennial ages only; and it consequently became necessary, before proceeding to the construction of the mortality table, to interpolate for the intermediate terms.

This was done by a most scientific mode of interpolation first suggested by M. Maurice in the *Connaissance des Temps* for 1847, and subsequently introduced into this country by Mr. Neison in his elaborate and most valuable report on the Bengal Military Fund.

The interval to be interpolated being $\frac{1}{5}$, the intermediate terms to be inserted between the original quantities are found as follows:—

Let $\Delta_1, \Delta_2, \Delta_3, =$ The 1st., 2nd., and 3rd, differences
of the original quantities.

And $a = \cdot 2 \Delta_1,$

$b = \cdot 04 \Delta_2,$

$c = \cdot 008 \Delta_3.$

$$\text{1st. } \delta_1 = a - 2b + 6c,$$

$$\text{1st. } \delta_2 = b - 4c,$$

$$\delta_3 = c \text{ (constant.)}$$

In some instances it was found necessary to interpolate from the original quantities for decennial periods of age, and in these cases the interval of $\frac{1}{2}$ was first found in the following manner:—

As before, Let

$$\Delta_1, \Delta_2, \Delta_3, = \text{1st, 2nd, and 3rd, Differ.}$$

$$\text{and } \alpha = .5\Delta_1,$$

$$\beta = .25\Delta_2,$$

$$\gamma = .125\Delta_3,$$

$$\text{Then 1st } \delta_1 = \alpha - .5\beta + .5\gamma,$$

$$\delta_2 = \beta - \gamma.$$

Having thus arrived at the mortality per cent. for every period or age of life, it became necessary to construct a table of decrements, that, is a table showing the number dying at each age out of, say 100,000, living at the age of 20.

Let d = The mortality per cent.

l = The number living,

$$\text{and } \log. \left(1 - \frac{d}{100}\right) = c.$$

Then taking 100,000 living as the standard

$$5 + \Sigma (c) = \lambda l.$$

With the object of applying these results to the purposes of assurance, the ordinary D and N columns, on Davics's principle, were constructed.

$$\text{In which } l_m \cdot v^m = D_m$$

$$\text{and } \Sigma (D_m) = N_{m-1},$$

and consequently the annual premium for assurance

$$\frac{D_m}{N_{m-1}} - (1 - r).$$

The processes here described have been applied to each disease: and other investigations, such as the influence of the primary disease on the immediate cause of death, profession, or occupation are being made. As, however, the *modus operandi* varies with almost each disease, it has been thought better not to include them in the present paper, but to give them separately as the diseases come under discussion.

A thorough investigation into the influence of trade or occupation on health and longevity, and the peculiar diseases to which they are subject, must prove of immense value in a medical as well as a commercial point of view.

The papers brought before the Statistical Society by Colonel Sykes, Mr. Neison, and Dr. Guy, supply considerable amount of information on this point, but a large bulk of the trades and occupations still remain to be investigated.

The great difficulty of obtaining information and data in order effectively to carry out these investigations is certainly much to be deplored. It cannot be disputed that if we were enabled to ascertain the causes producing the different effects which tend to shorten life in the various occupations, remedies might be applied which would contribute greatly to improve not only the physical but the moral condition of society. Great opposition is felt by all classes against investigations into subjects of this kind ; in fact every man wishes to be considered perfectly healthy.

The following extract from Mr. Thackrah's valuable treatise on *The Effects of Arts, Trades, and Professions on Health and Longevity*, maintains this opinion.

“ Either diseases are artificially multiplied or they are not. If enquiry prove the affirmative, surely self-interest as well as benevolence demands a full investigation into the causes of the evil :—if the negative, we shall rest contented, gratified with the idea that our employments are not baneful, and that the excess of mortality is the influence of Providence, ‘ not the agency of man.’

“ Most persons who reflect on the subject, will be inclined to admit that our employments are in a considerable degree injurious to health, but they believe, or profess to believe, that the evils cannot be counteracted, and urge that an investigation of such evils can produce only pain and discontent.”

Whatever may be the present impression on this subject, it is quite certain that, as society advances, the question must and will be thoroughly investigated. With increase of intelligence the artizan will insist on knowing the effect produced by his occupation on the duration of life. The system of evading such investigations cannot be sustained ; and if it could, it certainly ought not to be. Society has no right to take advantage of the ignorance of certain classes of workmen, and obtain

from them labour fraught with danger without seeking means to alleviate it; or at all events offering some compensation to the families of men thus exposed to great risks. It becomes also a matter of the greatest importance to Assurance Offices, and most especially to those whose business is chiefly of an industrial kind.

According to the present knowledge of the subject whole trades must be excluded from the advantages of Life Assurance. So important, indeed, is this matter, that it is incumbent on the Government to afford its aid towards the collection of facts upon this subject. The social welfare of the people is so intimately connected with sanitary provisions, with the safety of property, and the peace of society, that too great stress cannot be laid upon the value of promoting the science of statistics, which is capable of eliciting such beneficial and important results.

We shall not at present further pursue this branch of the subject of diseased lives, but make it hereafter an especial object of consideration, as being one of the most important inquiries of Vital Statistics. Before leaving it, however, it is impossible not to express the deepest regret, not unmixed with surprise, that the Government of a great and enlightened nation should leave so vast a matter to the investigation of solitary men of science, and to individuals who, whatever may be their zeal and ability, can scarcely possess themselves of the machinery for so complex and comprehensive an enquiry.

In returning, however, to the more immediate subject of the present paper, the mode of applying assurance to the purposes of diseased lives, we will consider the effect produced by the present system of granting immediate annuities.

Granting an immediate annuity for a sum paid down, is the exact reverse of the commonest process of Life Assurance which grants a deferred amount for an immediate premium. Now, it is somewhat strange, that the principle adopted in one case should be entirely different to that used in the other. In granting a Life Assurance the utmost enquiry is made as to the health of the individual in order that only such lives may be taken as will probably extend through the average number of years. This is justice to the office. But there also should be justice to the purchaser of an annuity. Now in the case of granting immediate annuities, it is certainly equally just that the purchaser

should gain the advantage of having his probability of life calculated, and if it be short, that he should be allowed a larger annuity.

That the principle of calculating the probability of life and classing each individual ought to be carried out, there can be no doubt. Should a man labour under a disease which must inevitably shorten life, it is right he should have the advantage of this circumstance as much as that the Office should have the advantage of his healthy state if assuring for a sum at death. Disease is charged extra in assurance; and, therefore, it ought to be allowed in an annuity; and that this principle, now only adopted by one or two Offices, will ultimately become general, there can be no doubt. It is one deserving the notice of those investing their capital in annuities, and the Offices* that have had the honesty and sagacity to commence acting on the principle deserve encouragement.

The application of the Tables of Diseased Lives requires some elucidation, and I shall endeavour briefly to explain to the medical profession the proceeding necessary to make them available.

The first thing to be considered is the class into which lives may be divided, which may roughly be said to be four.

1st.—Healthy (average) state.

2nd.—Tainted, not being the average of health, nor with tendency to any disease.

3rd.—Tendency to disease.

4th.—Positive disease.

With regard to the first class, it is not in our province to enlarge; but with regard to the second and third it requires the utmost nicety and sagacity to report.

The first point to be reported by the medical examiner is the disease; secondly, its stage or intensity; thirdly, its relation to the constitution of the individual.

It is of the utmost importance to the Office that it should be informed of the state of the patient, so as to classify him, and bring him within the average of the particular condition he may be in. For instance, if he be afflicted with consumption, the Office will affix a rate according to the stage at which the disease has arrived. It will take into conside-

* Medical, Invalid, and General Life Assurance Company; and the Athenæum Life Assurance Company.

ration age, sex, mode and place of living, &c., and arrange them in three or four classes, according as may be decided by the best medical authority. Of course the rates will greatly increase as the most dangerous period of disease is approached.

With regard to the third class—the tendency to disease—this requires, in addition to medical enquiry, others of a moral and social nature, such as the hereditary state; mode of life; temperament; moral disposition; occupation; locality; &c. The medical examination must be made with every aid that medical science can afford; so that even the remotest indications of disease may be recognised.

There would be, to a certain extent, classification of tendency into apparent or slight; determined and absolute; and imminent or approaching disease.

There are many conditions of the system in which the medical referee is unable to state that the applicant is of decidedly unhealthy constitution, in so far that there may exist that peculiar diathesis which, though perfectly compatible with present immunity from actual disease, departs withal from what is considered to be the normal standard of health. Thus, a person may be of a scrofulous constitution, yet in the enjoyment of that degree of health which shall be considered, for the diathesis, perfect of its kind; but although the seeds of disease have been sown, their germination is simply in abeyance: and here the judgment of the medical man will be taxed so that such a life may not be rated on the same scale as one in which there is no evidence of the existence of this peculiar form of constitutional taint. Moreover, much will depend upon the circumstances of life in which the applicant is placed—the salubrity of the locality in which he resides—his habits in respect of the amount of care bestowed by him in avoiding those causes which tend to excite diseases lying dormant, &c. In my next paper I propose to enter more fully into the consideration of the above important topics.

The improvements which have of late years resulted from the great advances made in the subjects of physiology and pathology have tended materially to the establishment of more correct data for *diagnosis*, or “the discrimination of disease;” and have at the same time introduced in their train yet more scientific plans of treatment; while the investigations of modern chemists and pharmacutists are continually

supplying valuable additions to the *materia medica*, so that *prognosis* too, or "the opinion on result," will also be greatly influenced by the above consideration. These are points which the medical referee must always bear in mind, and this officer should be one who has made it his duty to be informed upon the present advance in medical science, not only that he may most efficiently minister to the wants of suffering humanity, but that he may decide more correctly upon the peculiarity of the disease presented to him, and report more faithfully upon its precise nature and ultimate probabilities.

Perhaps there is nothing more difficult for the medical practitioner than the determination of that initiatory state (so to term it) of the system in which disease, often of a formidable character, is threatening to undermine the constitution, and lead, it may be, to lingering illness and premature death. Here a want of professional acumen, tending to a faulty diagnosis, would lead an office into an important error, and be productive of serious loss.

Disease is often of the most insidious character, and requires to be tracked with the same subtlety as that by which it has itself made progress. In illustration I may refer to that malady which, within the last few years, has occupied a considerable share of medical attention, and which we not unfrequently find noticed in the public prints, where inquests have been held in cases of sudden death, and a verdict returned that decease resulted from fatty degeneration of the heart. And although this affection is stated to exist to a greater or less extent in the decline of life, and is but in strict accordance with that general enfeeblement of the vital powers, which now no longer necessitates so active a circulation of the blood as formerly; the same condition withal may occur at a much earlier date, and be even the associate of the youthful. Although the means of determining the presence of this affection is acknowledged by medical men to be obscure, there has lately been an additional and important point brought to light by Mr. Edwin Canton,* who discovered that the peculiar blueish-white ring (*arcus senilis*) which marks the cornea of the eye after the age of fifty, and which he states to be a fatty degeneration of this texture, will be found associated with the same condition of the

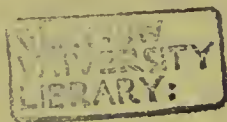
* The *Lancet*, May 11th, 1850.

heart-fibre, whether the person be old or young. The discoverer believes that this condition of the eye will aid materially in the diagnosis of the state of the heart.*

In attempting to cope with so vast a subject as the reduction of Diseased Lives to the purposes of Life Assurance, every allowance, it is hoped, will be made for the comparatively slight results yet obtained. The pioneers in such a matter have to encounter all the difficulties of those who seek to subdue regions yet untrodden by science and labour. To well directed perseverance, however, all things give way, and I may confidently assert that having worked ardently in the attempt I feel assured that the most favourable progress will be made in it; and that when general attention is directed to the subject, and talent and industry find that a proportionate reward will follow their labours, discoveries will be made and systems of enquiry framed, which will still further extend the science of Vital Statistics.

So important will the facts thus discovered and systematised be considered, that it will be acknowledged that the attempt commenced a second era of Life Assurance, which will show in contrast to the first as the full light of the science compared with its early dawn. To accomplish this, however, much remains to be done, and no single labourer, however industrious or however intelligent, can accomplish it. All that I have aimed at is to arouse an earnest feeling on the subject, and in engaging attention to the subject to secure the co-operation of the mental power of the country.

I claim but the merit of the pioneer, and shall be ready to give way, when I have opened a slight path, to the more experienced and powerful minds which will inevitably follow in the track.



* In a paper published by Mr. Dobell in the *Medical Times* on "The Medical Examination of Lives for Assurance," will be found introduced the question—"If an arcus round the cornea—if slight or well-marked?"

